IMPACT ON KILLER WHALES

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Impact of Human Activities on Killer Whales at the Rubbing Beaches in the Robson Bight Ecological Reserve and Adjacent Waters During the Summers of 1987 and 1989.

David Briggs Report

BC Parks
Ministry of Parks
Hon. John L. Savage
Minister

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EXECUTIVE SUMMARY

Killer whales regularly visit Johnstone Strait. These orcas, members of the northern resident population, use rubbing beaches at Robson Bight. The rubbing beaches are well known as important orca habitat. Public interest has increased since Robson Bight Ecological Reserve was created in 1982. People are concerned that human activity on the reserve and adjacent waters may threaten whales' use of the beaches.

This study was commissioned by the Ministry of Parks to examine the impact of human activity on the behaviour of orcas at the rubbing beaches. It was conducted during July and August 1989 at the rubbing beaches. The study team made observations from blinds hidden from view of boaters and whales. Observations from a similar study in 1987 are also considered in the analysis.

Whale Use of Johnstone Strait and the Rubbing Beaches

A total of 189 whales were counted in the northern resident population of killer whales in 1989. Of these, a total of 16 pods with 133 whales frequented Johnstone Strait during the study period. More than 90 per cent of the whales seen in Johnstone Strait were observed at the rubbing beaches during the 1987 and 1989 study periods. Whales visited the beaches on most days that they entered the strait. The number of whales visiting the beaches at any one time ranged from several individuals to more than 90.

The length of time that whales spent at the beaches ranged from several minutes to just under four hours. In 1987 and 1989, whales in Johnstone Strait spent ten per cent and nine per cent of their time respectively at the beaches. Although the proportion of whales present in Johnstone Strait who also frequent the beaches has not changed, there are indications that whales may be spending less time at the beaches than previously recorded. Proportionately, the decline in time spent by whales at the beaches is greater than that showed in the Strait.

Whale/Human Interaction on Water

Vessels accounted for most of the human activity at the rubbing beaches during both 1987 and 1989. Commercial fishing boats, which are exempt from reserve restrictions, accounted for 84 per cent of the marine traffic. During July and August 1989, commercial fishing boats were present for 24 hours each day, 4-5 days a week. They often moored at or near the rubbing beaches, fished, watched whales and landed on the beaches.

Recreational boaters, kayakers and general marine traffic made up the remaining 16 per cent of vessels at Robson Bight. However, a BC Parks visitor information officer intercepted many recreational boaters, diverting them from the reserve, and providing information on the reserve and the whales, and with a pamphlet outlining whale-watching guidelines.

In the waters immediately adjacent to the ecological reserve, whales approaching the reserve were usually accompanied by commercial and recreational whale-watching boats. When boats were present, whales usually spent less time in the reserve and rubbing at the beaches. Again, in that area, most of the vessel interactions with whales were by commercial fishermen (78 per cent) and the majority of remaining interactions were by recreational boats (14 per cent).

Interactions on the water resulted in a reaction by the whales 76 per cent of the time, with the whales leaving the area (most common), rubbing for shorter periods or spending less time in the reserve.

Whale/Human Interaction on Land

Very few interactions resulted from the presence of people on land as access by land is limited in that area. However, in every instance recorded, whales left the reserve when people were on shore east of Schmidt Creek. The only records of human activity on lands adjacent to the reserve were observed east of the reserve, east of Schmidt Creek, where a logging road was constructed and logging took place. In the reserve, some commercial fisherman landed their skiffs near the beaches.

Analysis

The study indicates that interaction between vessels and whales both at the rubbing beaches and in the waters immediately adjacent to the reserve clearly alters whale use of rubbing beaches in the short term. Interactions resulting from the presence of people on shore in all instances resulted in whales leaving the area.

Although the study may not be long enough to detect meaningful long-term impacts, there are indications that the use of the reserve by whales may have declined from that observed ten years ago. Furthermore, the decline in whale usage observed at rubbing beaches may be proportionately greater than that observed in the Strait in general.

Conclusion

At this time, we cannot be sure whether the decline in Johnstone Strait and at Robson Bight rubbing beaches has resulted from an accumulation of human disturbances in the region or whether it has resulted from other environmental changes, such as food supply. The number of whales observed in the Strait and in the reserve has decreased from previous years. The reason for this is unknown. However, the larger decrease in the time spent by whales at the beaches suggests it may be independent from the decrease observed in the Strait and that human disturbance may be a factor in that decline.

INTRODUCTION

The rubbing beaches in Robson Bight Ecological Reserve in northern Johnstone Strait, British Columbia, are well known as an important killer whale habitat (Ford, 1981; Bigg, 1982; Rennie, 1982; Darling, 1986; Blood et al., 1988). This provincial reserve was established in 1982 "...to protect key habitats for killer whales, prevent their harassment while using those habitats and maintain unique opportunities to research and observe killer whales; (and) to protect a pristine estuary and forested shorelines." (Ministry of Parks, 1987). The reserve is utilized by northern resident killer whales, a population which consists of 16 family groups or pods. This population increased in size by 5% from 180 to 189 between 1987 and 1989 (Appendix Tables 1 and 2; M. Bigg, pers. comm.).

Studies by Kruse (1984), Briggs (1985), Darling (1986), Duffus and Dearden (1987) and Taylor (1988a,b) have examined some aspects of human impacts on killer whales in Johnstone Strait. But no detailed study was carried out at the rubbing beaches, the key habitat which attracts the whales to the reserve. Yet, there was much concern that human activities such as whale watching, commercial fishing and logging in the reserve or adjacent waters and lands might threaten killer whale use of this key habitat. This is why in 1987, and again in 1989, the author was commissioned by the B.C. Ministry of Parks (Briggs, 1988) to examine the impact of human activities on killer whales at the rubbing beaches. The B.C. Ministry of Parks also instituted an information officer program to inform visitors of boater restrictions in the reserve starting in 1987.

The 1987 study (Briggs, 1988) documented usage of the rubbing beaches by the northern resident community of killer whales, human activity at or near the beaches and the impact of human activity on the whales during July and August. This 1987 study raised concerns that human disturbance in the reserve may cause the whales to leave the reserve. This study was repeated in 1989 to obtain additional data.

The 1989 study investigates further the impact of human activity on whale behaviour at the rubbing beaches. A field study was conducted from blinds at the two main rubbing beaches in the reserve during July-August 1989. Although two types of killer whale, called residents and transients, use the Johnstone Strait area, only the residents are considered here because transients do not use the rubbing beaches. The 1989 report incorporates the results of the 1987 field season.

METHODS

A. ROBSON BIGHT STUDY AREA

The study area (Fig. 1) includes three zones. The first zone for recording data is Johnstone Strait and for the purpose of this study includes the waters of Johnstone Strait from the west end of Hanson Island to the east end of the reserve, and not north of Blackney Pass. The second zone for recording data is the water adjacent to the reserve and includes the waters of Johnstone Strait from approximately the western boundary of the Robson Bight reserve to approximately 1 km east of the eastern boundary and extends to West Cracroft Island across the strait. The third study zone, referred to as the rubbing beaches zone, extends to 300 m offshore from the rubbing beach, and also includes the lands on shore at, and immediately adjacent to, the rubbing beaches.

The two campsites used during the 1987 study were again used in 1989. They were hidden among the trees and brush to ensure that neither killer whales nor people in boats could see them. Travel by boat to and from these camps did not occur more than once a week and was postponed if whales were present.

B. DATA COLLECTING PROCEDURES

Research was conducted at the two main rubbing beaches in the reserve from July 1 to August 27, 1987 (58 days), and from July 1 to August 31 (60 days) 1989. A minimum of two observers operated at each site. Observations of whale activity were made 24 hours a day; human activity was primarily recorded during daylight hours. During the day, individual whales were recognized visually by their unique natural markings (Bigg et al., 1987). At night, pods were recognized acoustically using a hydrophone to identify their dialects (Ford and Fisher, 1982).

Data collected on whale activity included: the time of day; the identity of individual whales; their location; direction of travel; activity state; and distance from shore. Normal whale activities include foraging, travelling, resting, rubbing and socializing (for descriptions see Ford, 1984). For this study, travelling, resting and rubbing were the primary activities recorded. Whales at the rubbing beaches were noted as to whether they rubbed and for how long. Whales were recorded as being in Johnstone Strait once they entered the first zone. Whale approaches to the reserve and human activities in the waters adjacent to the reserve occured in the second zone. Whale and human activities at the rubbing beaches occurred in the third zone (see Study Area, above).

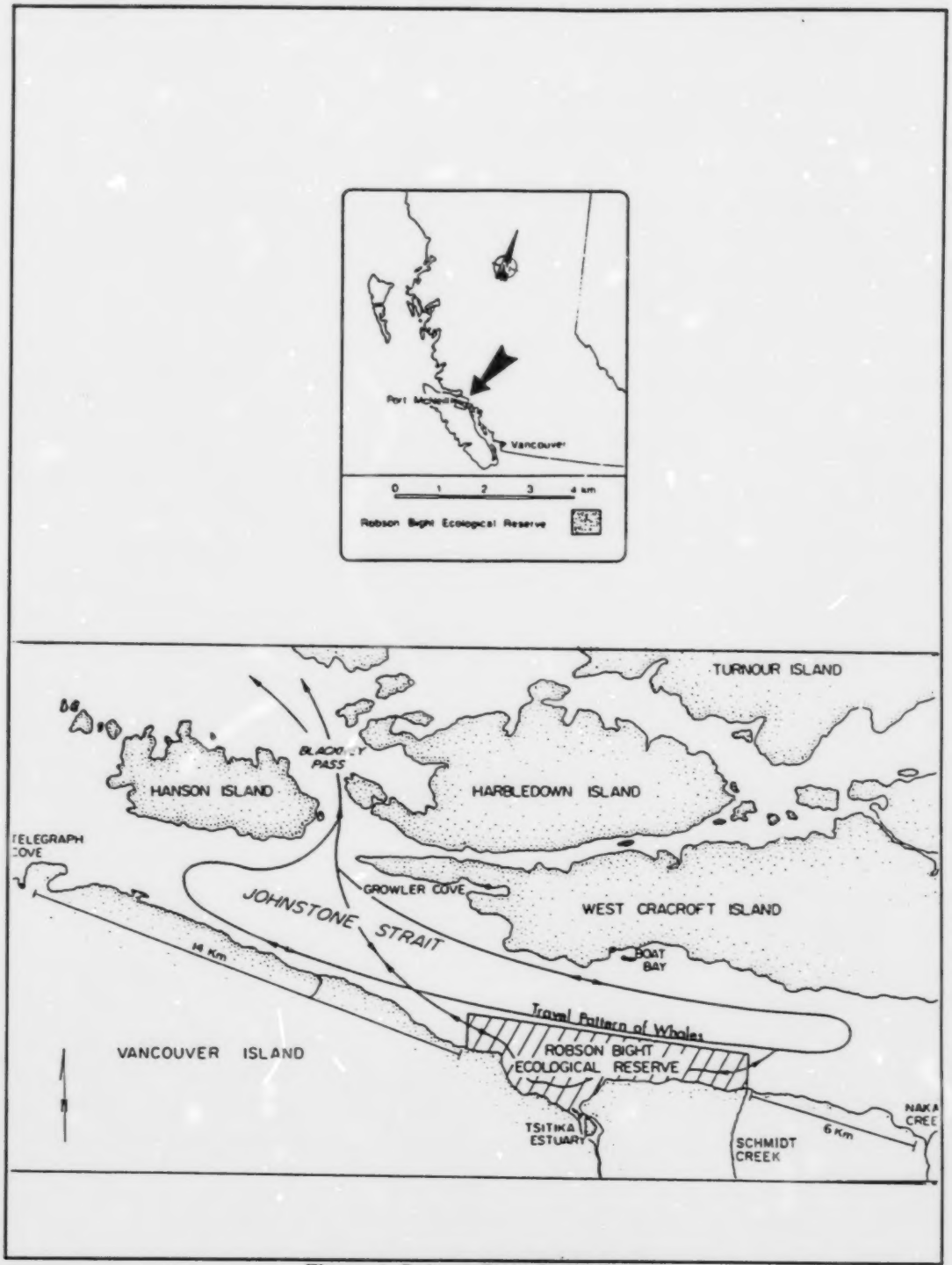

Figure 1: Robson Bight Study Area

A killer whale family group or "pod"* was recorded as being present if any of its members were observed within the study area. The specific "subpods"** and the precise number of individuals present were also noted whenever possible. The presence of a "subpod" was defined as including all or some of the members of that subpod. For the purposes of analysis, whale activities are broadly defined as follows:

- **one whale visit**: one arrival and continuous activity period at the rubbing beaches by one or more whales. A visit at one or both of the rubbing beach areas was still counted as one whale visit.
- **one whale-day**: one individual whale present on a given day. Total whale-days were calculated by adding the total number of days during which each individual whale was present. For example, if whale A was present on 5 days and whale B was present on 12 days, this would account for a total of 17 whale days.
- **one whale-hour**: one individual whale present for one hour. Total whale-hours were calculated by adding the total number of hours during which each individual whale was present.

The levels of commercial fishing traffic, commercial and recreational whale-watching, and general marine traffic were recorded. Human activities on land included walking on shore, fishing tie-ups, gunfire, picnicking, making fires, camping and logging.

Data recorded to document vessel activity included: vessel type; distance of vessel from shore and proximity to rubbing beaches; direction of travel; direction and distance from whales; and type of activity for commercial fishing boats. Types of fishing vessel were categorized as: commercial fishing boat travelling (cbt); commercial fishing boat fishing (cbf); and commercial fishing boat skiff (cbs). General marine traffic (gm) included tugs, tankers, cruise-ships, coast guard and fishery patrol boats. Recreational boats (rb) included mainly small and large motorized pleasure craft and sailboats, as well as research and photography All pleasure craft were assumed to be recreational traffic although some were observed running supplies and people to the fishing boats moored in the area, and the purpose of their visit may have been related to commercial fishing. A "**boat visit**" was defined as one arrival to the rubbing beaches by one boat. One boat could make several visits in one day.

For boats, a "whale-boat interaction " (which may or may not have elicited a whale reaction) was considered to have taken place when the boat was within 300 m of a killer whale. This distance is

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*A "pod" is one or more "subpods" that tend to travel together (Bigg et.al. 1987)

**A "subpod" is one or more maternal groups (mother and her offspring) that tend to travel together (Bigg et.al. 1987).

conservative because Kruse (1984) reported that whales reacted when boats were within 400 m of the focal animals. One whale-vessel interaction could involve one or more boats; conversely, one boat could be involved in several interactions. Similarly, shore-based interaction between people and whales was considered to have taken place when people were on shore at the rubbing beaches while whales were present. Whale responses to there interactions were noted. The following terms were used to describe whale responses to an interaction:

1. No Reaction: No visible change in behaviour of the whale was observed.
2. Reaction: Evidence of some change in typical behaviour of the whale was observed. Evidence of reaction was classified as follows:

a. Leave the Area: The whales left the beaches within one minute from the time that the interaction began and did not return.

b. Change Direction: The whales stopped travelling towards the beaches, changed their direction of travel away from the beaches and continued in a direction away from the beaches.

c. Passed By: The whales were inside the 0-300 m area in front of the beaches, but did not stop to rub.

d. Leave and Return: The whales moved further away from the beaches within one minute from the beginning of the interaction, but then returned within five minutes following the interaction.

e. Short Rub: The whales remained at the beaches for less than 10 minutes, which is an abbreviated rub.

f. Wait to Rub: The whales stopped travelling toward the beaches during the interaction and either changed their speed or direction of travel, but subsequently continued on to the beaches following the interaction.

The whale data obtained at the rubbing beaches has been supplemented by data on whale presence in Johnstone Strait wherever possible to provide some perspective. Other researchers responsible for the collection of these data are Dr. Paul Spong and Ms. Helena Symonds (OrcaLab), Mr. Jeff Jacobsen (Humboldt State University), and Ms. Linda Nichol (University of British Columbia).

RESULTS

A. KILLER WHALE DISTRIBUTION

More than 370 killer whales frequent the coastal waters of British Columbia. At least 280 of these are "resident" whales which are culturally specialized as fish eaters. The remainder are transients, a distinct population of whales that prey primarily on marine mammals. The resident population is separated into two communities: northern and southern. This report is concerned strictly with the former community.

The northern resident community of killer whales consists of 16 pods or family groups, with a total population of 189 in 1989. The known range of the northern residents extends from mid-way down Vancouver Island to northern British Columbia, excluding most of the west coast of Vancouver Island and the Queen Charlotte Islands (Bigg et al. 1987). Although they may be seen anywhere in this range over the past 20 years, most pods are usually found in northern Johnstone Strait at some time between June and November each year. Such a predictable presence of killer whales appears to be unique, and for this reason, northern Johnstone Strait has been labelled "core" habitat for the northern resident community of killer whales.

1. Killer Whale Presence in Johnstone Strait

The number of whales observed in Johnstone Strait during July and August of 1987, 1988 and 1989 was recorded as being respectively 157, 112 and 133 whales (Table 1). Data for 1988 was gathered from detailed records of sightings by the researchers in the area during 1988. Although the number of whales seen in the Strait decreased slightly (15%) between 1987 and 1989, the time they spent there decreased by at least 40 % during that same period, as indicated by the numbers of days and hours whales were seen (whale-days and whale-hours respectively). Most whales were sighted on fewer days during 1988 than in 1987 and on even fewer days during 1989.

On average, the length of each whale visit to Johnstone Strait declined (Table 1). In 1987, individual whales were spending 1.8 hours per day in the area. In 1989, individuals were spending only 1.1 hours. This is partially a result of the decline in diversity of subpods visiting the Strait.

All 16 resident pods visited Johnstone Strait during July and August 1987 and 1989. Figure 2 shows the usage of Johnstone Strait by each pod, based on the index of whale-days. Pods A1, A5, C1, A4 and D1 used the strait most often. The diversity of pods entering the Strait also declined between 1987 and 1989 (Figure 3). The A14 subgroup, seen on 30 days in the Strait in 1987, was seen only 6 times in 1989. D pod was not seen at all in 1989. This decline was observed for all subpods except two, the A30s and the C5s. The A30s were seen on 47 days in 1987 and 52 days in 1989. The C5s exhibited the most dramatic increase, with members of that subpod seen on only 18 days in 1987 and 40 days in 1989.

Table 1. Number of Individual Killer Whales Sighted in Johnstone Strait during July-August, 1987, 1988 and 1989.

	1987	1988	1989	1987-89
N. Resident Population[1]	180	185	189	+5%
# in Johnstone Strait[1]	157	112	133	-15%
By Individual				
Total whale days[2,3]	1,726	1,084	937	-46%
Total whale hours[4]	16,294	-	8,714	-47%
Mean # hrs./whale/day	1.8	-	1.1	-39%
By Pod				
Mean # days/pod[2]	9.9	6.6	4.6	-54%
Total # of visits	155	-	115	-26%
Mean # visits/day	2.67	-	1.92	-28%

1. See Appendix Table 1 and Appendix Table 2 for further details.
2. See Appendix Table 3 and Appendix Table 4 for further details.
3. Whale Days = Number of Subgroup Members x Number of Days Observed.
4. See Appendix Table 7 for further details.

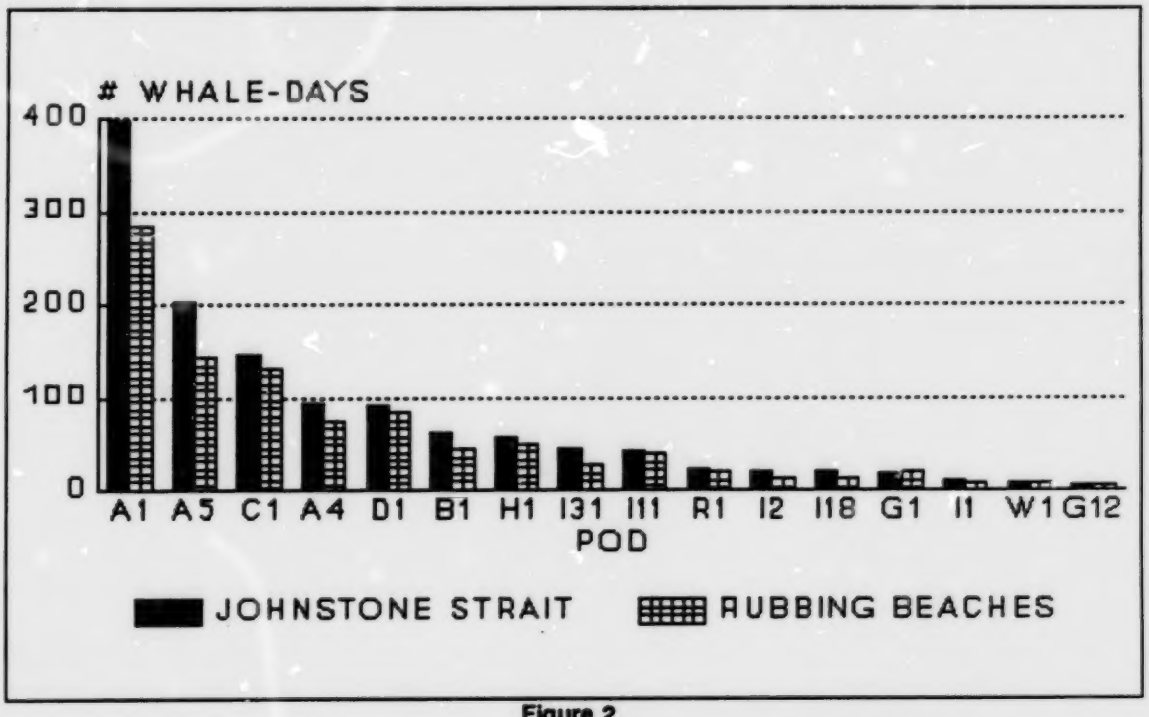

Figure 2.
The Overall Usage of Johnstone Strait and the Rubbing Beaches by Orca Pods During July-August, 1987 and 1989; as Indicated by the Number of Whale-Days.

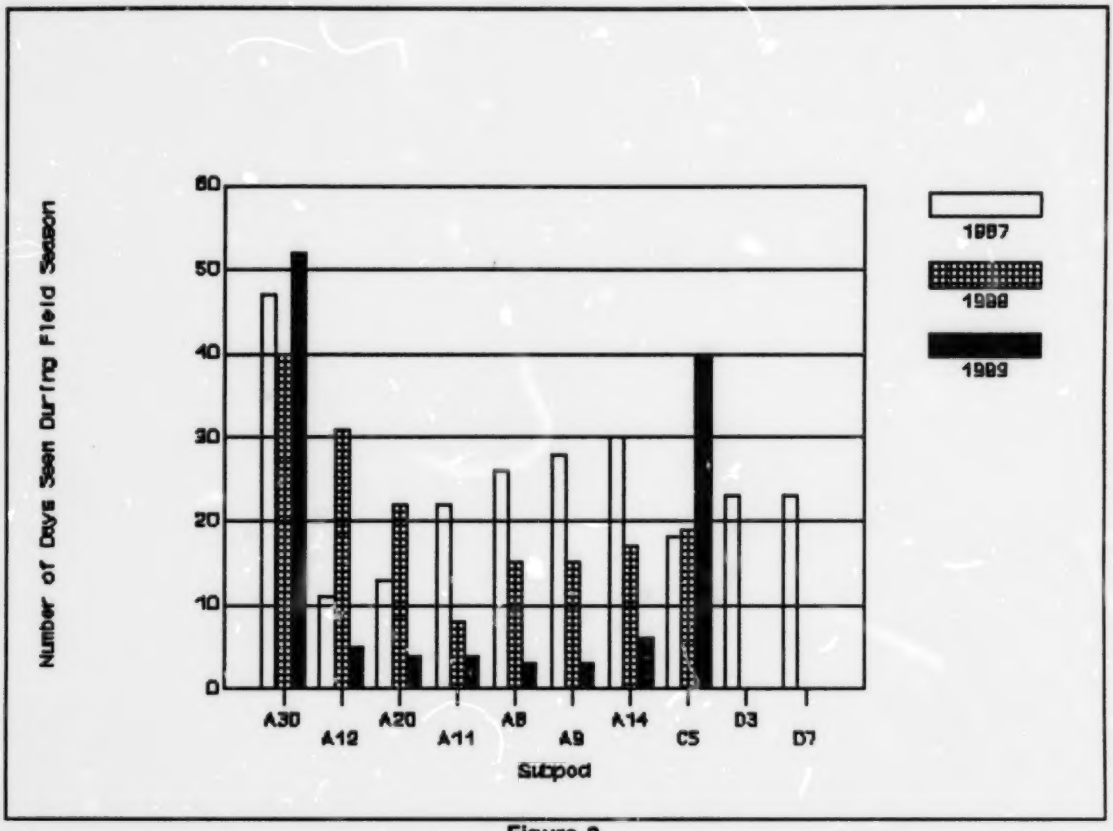

Figure 3.
Whales Sub-pods Seen Most Frequently in Johnstone Strait, 1987 to 1989.
Subpods Seen on More Than 20 Days in Any One Year are Included.

2. Killer Whale Presence at the Rubbing Beaches

Rubbing beach use shows a similar pattern of use to that observed in Johnstone Strait as a whole (Figure 2). All pods visited the beaches on most of the days that they visited the Strait. As in Johnstone Strait, pods A1, A5, C1, A4 and D1 used the rubbing beaches most often. (See Appendix Tables 3 and 4 for a breakdown of usage by year).

Whale-days at the rubbing beaches (Table 2) declined at a similar rate to those in Johnstone Strait as a whole. Although the decline for rubbing beach use was slightly greater than that noted for Johnstone Strait, this difference was not significant. For example, total whale-days at the beaches decreased by 50% and by 46% in the Strait between 1987 and 1989. Similarly, the percentage of hours spent at the beaches of total time in Johnstone Strait declined from 10% to 9% (Table 3), but this was not significant.

Table 2. Occurrence of Killer Whales by Individual and by Pod at the **Rubbing Beaches** during July-August 1987 and 1989.

	1987	1989	% Change 1987/89
# at rubbing beaches	142	123	-13%
By Individual Whale			
Total whale-days	1,288	645	-50%
Total whale-hours	1,673	789	-53%
Mean # hours/whale	11.8	6.4	-46%
By Pod			
Mean # days/pod	7.5	3.2	-57%
Total # visits	179	97	-46%
Mean # visits/day	3.08	1.62	-47%

Table 3. Comparison of Killer Whale Occurrence in Johnstone Strait and at the Rubbing Beaches during July-August, 1987 and 1989.

By Individual	1987	1989
# in Johnstone Strait	157	133
# at rubbing beaches	142	123
% of whales in Johnstone Strait at rubbing beaches	90.4%	92.5%
% of whale-hours in Johnstone Strait at rubbing beaches	10%	9%

The length of time that whales spent at the beaches ranged from several minutes tc just under four hours. On a daily basis, the average time spent at the beaches declined between 1987 and 1989 from 0.2 hours to 0.1 hours (Table 2 and Appendix Table 7). This represented a 50% decrease in time.

B. HUMAN ACTIVITY

1. Human Presence at the Rubbing Beaches

a. Vessel Activity at the Rubbing Beaches

Vessel activity accounted for 1047 approaches to the rubbing beaches during 1987 and 2408 approaches in 1989 (Table 4). Commercial fishing vessels were the predominant users of the area, approaching 827 times in 1987 and 2084 times in 1989. Seiners and gill-netters were present 24 hours a day for 4-7 days a week, once the fishing season opened. The number of beach approaches more than doubled during 1989 due to a longer fishing season. The season began in August in 1987 and in July in 1989.

In order to catch salmon migrating along the shoreline, commercial boats commonly fished close to the rubbing beach area. Seiners often lined up at the beaches to make sets and gill-netters also fished within 10 to 50 m from shore. Fishing boats moored in coves immediately adjacent to the beaches for several days between weekly openings during 1987 and 1989. Commercial vessels sometimes moored directly over the rubbing beaches.

Other users consisted mainly of recreational boaters, kayakers and general marine traffic. As mentioned in the Methods, many of the recreational boats may have been part of commercial fishing activities.

A large number of gunshots, from commercial fishing boats moored at the beaches, were recorded during 1987 and 1989, but were only quantified during 1989. Gunfire was heard on 35% of the days that commercial fishing vessels were moored. More than 500 shots were fired in 1989. Most shooting was directed at shore, but on several occasions objects in the water, including leaping salmon, were targets. Gunfire was heard on two occasions when whales were at the beaches. In these cases, the shooting was apparently at targets on shore. In addition, explosives, possibly "seal bombs", were thrown into the water on one occasion during 1989, although no whales were present. A possible shooting at whales occurred in 1987, when a gill-netter
fishing just off the rubbing beaches suddenly drove his boat in the direction of a group of whales engaged in rubbing. Two explosions were heard as the boat approached the whales.

All other boat types combined totalled 220 visits to the rubbing beaches in 1987 and 324 visits in 1989 (Table 4). Recreational boats were the second most numerous boat type to visit the beaches. Their numbers increased by more than half between 1987 and 1989. Recreational boats would often attempt to follow whales into the reserve. However, the visitor information officer would usually stop such boats.

During 1987, Taylor (1988b) contacted 557 whalewatchers who visited at or near Robson Bight in recreational boats. This represented 32% of the total visitors contacted for that year.

Kayaks visited the beaches less frequently in 1989 than 1987, but the number of landings by kayaks increased. The new logging road which extends to Schmidt Creek, on the eastern boundary of the reserve, was used by kayakers as access during 1987 and 1989.

Commercial whale watching visits into the study area, already very low, decreased from 6 visits in 1987 to 3 in 1989 (Table 4). Virtually all visits to the rubbing beaches in 1989 were by one vessel which was new to the area. Visits by other vessels were rare. (For a breakdown of vessel activity by type and distance from shore, see Appendix Table 8.) Commercial whale watching operators generally avoided entering the reserve as whales are just as easily seen outside the reserve. Many operators realize that the whales are easily disturbed when in the reserve.

General marine traffic vessels which passed close to the rubbing beaches were mainly fishery patrol boats. There were more fishery patrol boat visits in 1989 than in 1987 due to the lengthened fishing season. Tugs with log booms were also common. They travelled very close to shore (often within 100 m) and their propulsion systems emitted very high levels of noise into the water. The booms usually took several hours to pass through the area.

Table 4. Killer Whale Presence During Water-Based Activities at the Rubbing Beaches, July-August 1987 and 1989.

Approaches from Water	1987	1989
Total Approaches	1,047	2,408
Approaches when Whales present	191	170

Present	# Approaches		% Vessel Approaches when Whales	
	1987	1989	1987	1989
Commercial Fishing	827	2,084	14%	5%
Recreational Boats	108	181	2%	1%
Kayaks	72	47	>1%	>1%
General Marine	26	83	>1%	>1%
Research	7	9	>1%	>1%
Commercial Whale Watchers	6	3	>1%	>1%
Photographers	1	1	>1%	>1%
Total Non-Commercial Fishing	220	324	18%	7%

b. Human Activity on Shore at the Rubbing Beaches

Shore activity comprised less than 1% of the total activity at the rubbing beaches (Table 5). In 1989, the majority of landings and shore activity at the rubbing beaches were by commercial fishermen (Table 6) moored at the beaches between openings. In 1987, fishermen were not observed landing at the beaches; they accounted for 19 of 27 landings in 1989. They used skiffs to come ashore and stayed for periods of 5 to 50 minutes. Fishermen came ashore to hike, tie mooring lines, whale watch, check targets or make a fire. Despite their virtually constant presence at the beaches, fishermen were not aware of the research camp and only found it on one occasion.

Kayakers and recreational boaters accounted for the remainder of shore activities at the beaches . They often landed to look for a camp site. In addition, on July 30-31 1989, a pair of hikers walked to the rubbing beaches from Schmidt Creek via the new logging road. They photographed the whales rubbing. This is the first instance of people hiking in to the beaches of which we are aware. A new gate installed on that road now prevents this type of access.

Table 5. Summary of Human Activity at the Rubbing Beaches, July-August 1987 and 1989.

	1987		1989	
	#	%	#	%
Approaches from the water	1,047	99.8	2,408	99
Shore-based activity	2	0.2	27	1
Total	1,049	100	2,435	100

Table 6. Killer Whale Presence during Vessel Landings and Shore-Based Activities at the Rubbing Beaches, July-August, 1987 and 1989.

	1987	1989
Landings and Shore Based Activities		
Total Landings/Activity	2	27
Total When Whales Present	2	3
	% Vessel Landings When Whales Present	
Commercial Fishing Skiffs	0	11%
Kayaks	50%	13%
Recreational	50%	0
% When Whales Present	100%	11%
	# Vessel Landings (When Whales Present)	
Commercial Fishermen	0 (0)	19 (2)
Recreational Users	2 (2)	8 (1)

2. Human Activity on Land Adjacent to the Reserve

Table 7 shows the human activities on land adjacent to the reserve. Logging and logging-related engineering were the predominant activities. Dynamite explosions from road building were recorded. Most explosions apparently took place to the east of the reserve. Siltation was observed once in Schmidt Creek during 1989 after moderate rains. This may have resulted from road-building operations there on the previous day. None of this siltation reached the rubbing beaches.

During 1989, recreational users picnicked onshore adjacent to the reserve three times and camped three times. Whales were present during four of these instances. On at least one occasion, people entered the beach area by boat to view whales after seeing them from outside of the reserve. We received reports of other instances of day use that we did not see. Day use by recreational users on land adjacent to the eastern boundary of the reserve was not recorded during 1987, although it did occur.

Table 7. Human Activities on Land Adjacent to the Reserve During July-August, 1987 and 1989.

	1987	1989
Logging-associated (# of instances when whales present)		
Road blasts	16 (0)	9 (0)
Siltation in Schmidt Creek	0 (-)	1 (0)
Day use at Schmidt Creek (# when whales present)		
Picnicking	-	3 (1)
Camping	-	3 (3)

C. RESPONSES OF KILLER WHALES TO HUMAN ACTIVITY

Whales responded to 77% of the 411 interactions with human activities at the rubbing beaches and adjacent waters with a negative reaction (Table 8). Table 8 shows the frequency of interactions recorded with killer whales for various human activities.

Table 8. Incidence of Killer Whale Interactions with Human Activity on Land and on the Water at the Rubbing Beaches and adjacent to the reserve during July-August, 1987 and 1989.

	1987	1989	Total
Johnstone Strait *			
# whale approaches **	-	45	45
# vessel interactions	-	41 (91%)	41 (91%)
# reactions	-	30 (73%)	30 (73%)
Rubbing Beaches			
1. Vessel interactions	160	196	356
# Reactions	125 (78%)	145 (74%)	270 (76%)
	% Vessel Interactions with Reactions		
commercial fishboat	97 (61%)	98 (50%)	195 (55%)
recreational boat	17 (11%)	27 (14%)	44 (12%)
kayak	2 (1%)	11 (6%)	13 (4%)
general marine traffic	3 (2%)	7 (3%)	10 (3%)
commercial whale watch	3 (2%)	1 (1%)	4 (1%)
research	2 (1%)	1 (1%)	3 (1%)
photographers	1 (1%)	0 (0%)	1 (1%)
No Reaction	35 (22%)	51 (26%)	86 (24%)
Total	160 (100%)	196 (100%)	356 (100%)
1. Vessel landing interactions	2	4	6
# Reactions	2 (100%)	4 (100%)	6 (100%)
	% Vessel Landings with Reactions		
commercial fishboat	1 (50%)	2 (50%)	3 (50%)
recreation boat/kayak	1 (50%)	2 (50%)	3 (50%)
3. Day use interactions	2	3	5
# Reactions	2 (100%)	3 (100%)	5 (100%)
	% Day Use with Reactions		
commercial fishboat	0 (0%)	6 (67%)	2 (40%)
recreation boat/kayak	2 (100%)	1 (33%)	3 (60%)
4. Gunshot interactions	1	2	3
# Reactions	1 (100%)	1 (50%)	2 (67%)
	% Gunshot with Reactions		
commercial fishboat	1 (100%)	1 (50%)	2 (67%)
No Reaction	0	1 (50%)	1 (33%)

* Only a portion of the reserve and adjacent Johnstone Strait was monitored (see Table 8) from the observation blinds.

** Whales made 97 visits to the rubbing beaches during 1989. 45 were observed.

1. Killer Whale Responses in Johnstone Strait and Adjacent to the Reserve

Table 9 shows the frequency and type of responses by whales to vessels in Johnstone Strait immediately adjacent to the reserve. Most (91%) approaches by whales in the Strait to the reserve were associated with a vessel interaction. While not presented in tabular form, the majority of the interactions were with recreational and commercial whale watching boats and researchers. In 30 out of 41 cases (73%) in 1989, there was a change in behaviour by the whales. Whales reacted by short rubbing at the beaches, changing direction away from the beaches and passing by. Interactions were not quantified in 1987 for the Johnstone Strait area immediately adjacent to the reserve. Whales reacted by short rubbing at the beaches, changing direction away form the beaches and passing by. It should be noted however, that only 41 (42%) of the 97 killer whale approaches to the rubbing beaches were observed.

Groups of whales that were being followed by a boat often split up into two or more groups as they approached the beaches. If the boat stayed with one of the groups in waters adjacent to the reserve, the other group would often head to the beaches and undertake a shorter rub. The whales that used the beaches would try to keep up with the other whales that passed by offshore. Whales at the beaches would often leave when members of their pod, or other pods with which they were travelling, were disturbed. Even though those other members may by been outside the reserve. Whales outside of the reserve often changed direction away from the reserve when they encountered extensive boat activity in the reserve or adjacent waters. This boat activity was typically commercial fishing operations.

Table 9. Killer Whale Responses to Vessel Interaction during Approaches in Waters **Adjacent to the Ecological Reserve**, 1989.

No Reaction		11
Reaction ***		30
1.	Short Rub	10
2.	Change Direction	8
3.	Pass By	8
4.	Short Rub/Pass By	4
Total		41

*** See Methods for definitions of reaction types.
Responses observed when whales at or approaching rubbing beaches.
Vessel types included: commercial fishing, commercial and recreational whalewatching, research and general marine.

2. Killer Whale Responses at the Rubbing Beaches

a. Vessel Activity

Vessel activity accounted for 356 of a total 370 (including gunfire incidences) interactions with whales at the beaches during 1987 and 1989 (Table 8). The majority of reactions associated with water-based activity within 300 m of the rubbing beaches involved commercial fishing vessels. Commercial fishermen accounted for 61% of these interactions in 1987 and 50% in 1989. Commercial fishing vessel interactions with whales occurred as fishing boats passed through, fished, and/or whale watched.

The remainder of interactions at the rubbing beaches were with recreational and general marine traffic (Table 8). Recreational boat interactions occurred mostly during whale watching, but occasionally as the boat passed through the area. General marine traffic interactions occurred as boats passed through the area. Encounters with commercial fishing, recreational and general marine boats were higher during 1989 primarily due to an increased number of boat visits to the area. There were more kayak interactions in 1989 even though the number of kayak visits decreased. More kayaks were at the beaches when whales were present. Appendix Tables 9 and 10 provide details of interactions.

Table 10 lists the responses by whales to vessels at the rubbing beaches. Changes in whale behaviour were recorded in 76% of all interactions. The whales most commonly responded by leaving the area, in the case of commercial fishing and whale watching vessels and boats. Whales were more likely to react to general marine traffic by cutting a rubbing session short or by passing by the beaches. Additional detail is shown in Appendix Tables 12 and 13. Whales were more likely to react as:

- boats approached the shore
- boats approached the whales
- the number of successive passes by boats increased.

b. Shore Activity

Commercial fishermen and recreational users on shore accounted for approximately equal numbers of interactions with whales at the beaches during 1987 and 1989 (Table 8). All of these interactions resulted in a reaction by the whales. In the majority of observed reactions, the whales left (Table 11). Whales left the area every time that boats landed at the beaches and on all but one of the times that people walked around on shore.

Table 10. Killer Whale Responses to Vessel Interactions at the Rubbing Beaches During 1987 and 1989.

	Commercial Fishing	Whale Watching*	General Marine	Total
# Vessel Interactions	267	76	13	356
Whale Response (%)				
No reaction	27%	14%	23%	24%
Reaction				
Leave the area	31%	33%	0	31%
Short rub	16%	14%	31%	16%
Passed by	12%	16%	31%	13%
Leave and return	10%	17%	8%	11%
	3%	5%	0	4%
Wait to rub	>1%	0	8%	>1%
Change direction	100%	100%	100%	100%
Total				

* Whale watching includes commercial and recreational whale watching, research, and photography boats.

Table 11. Killer Whale Responses to Shore-based Activities at the Rubbing Beaches During 1987 and 1989.

Type and Activity	Total	% With Reaction	% Without Reaction
Shore landing by vessels	5 *	100 **	0
Human presence on shore	6 *	100 **	0
Gunfire by commercial fishermen	3 ?	67 **	33
	14 *	93 **	7
Total			

* Nine of the shore-based interactions resulted from the presence of commercial fishing boats, with the remainder (five) resulting from the activities of recreational whale watching vessels.

** Thirteen of the 14 whale reactions resulting from shore-based activities consisted of the whale leaving the area. In the remaining case, the whales had a short rub and them left the area.

There was one interaction associated with two gunshots or two small explosives involving a commercial fishing boat during 1987 (Table 8). The two explosions resulted in the whales leaving very rapidly and resurfacing several hundred meters away. Two other incidents of gunfire from commercial fishing boats while whales were present were recorded during 1989. In one case, 16 shots were fired, but no reaction by the whales was observed. In the other, two shots were fired and the whales left.

DISCUSSION

A. WHALE WATCHING TECHNIQUES

Commercial fishermen often displayed poor whale watching techniques. They approached whales rubbing at the beaches, often coming within 30 m of the whales and sometimes within 10 m. They cut whales off and drove their boats over top of and through groups of whales in attempts to view and photograph them. Skiffs from commercial fishing vessels also approached whales to whale watch, often coming within 10 m of the whales. Skiffs would frequently follow whales from one beach to the other or drift directly above the whales as they rubbed at the beaches. Normally such whale watching behaviour by any other vessels, such as commercial whale watching vessels, kayakers or small boats, would be reported to the B.C. Parks information officers. In those cases, the officers would then ask the boats to leave the reserve. However, boats engaged in commercial fishing activities in the reserve are not required to leave when whales are present. In the absence of the information officer, many more boats (other than commercial fishing vessels) would have visited the rubbing beaches. There is no record of how many boats were missed by the information officers.

Poor whale watching techniques were also exhibited by recreational boaters at the beaches. Whales were often cut off, passed by very closely at high speeds and repeatedly followed from one beach area to another. Recreational boaters sometimes behaved in this manner even after contact by the information officers.

B. HUMAN ACTIVITY ON SHORE AT THE RUBBING BEACHES

More camping by kayakers would have occurred at the beaches had the visitor information officer or our group not informed them of the reserve restrictions. As the reserve guidelines are not posted widely, much of this activity is occurring due to lack of education.

The number of landings by recreational boats increased during 1989. Two landings by recreational boats occurred at the beaches during 1987 and 8 were recorded during 1989. The majority of landing at the rubbing beaches during 1987 and 1989, however, were by commercial fishermen.

C. HUMAN ACTIVITY ON LAND ADJACENT TO AND IN THE RESERVE

Although there were only a small number of observations of land-based activity in and adjacent to the reserve, if there were whales present during this activity, they reacted with an avoidance response in 13 out of 14 observations. This finding is extremely important in relation to land access to the beaches. Proposals for constructing whale watching blinds have been entertained by several interest groups. In addition, the increasing number of logging roads in the area is making the area more accessible. It will be critical to ensure that no trails from these logging roads become established to the beaches, since regular land-based visitation will have serious consequences for the whales' use of this key habitat. Any proposal to enhance land-based viewing of the whales must also be reviewed critically for potential impacts on the whales. Currently a logging road is located east of the reserve, east of Schmidt Creek; another road goes down the Tsitika watershed and stops approximately 2.5km from the Robson Bight reserve. Both roads are gated to present access.

As was mentioned earlier, one siltation event occurred in Schmidt Creek during 1989. It was not observed to have affected water quality at the beaches, however, baseline information and a monitoring program would provide useful information regarding potential silt accumulation on the beaches. The Tsitika was not in view from the beaches and was not observed. It would be useful to undertake siltation studies in that area as well as sediments could be transported by currents to the rubbing beaches, possibly smothering the pebbles on which the whales rub.

D. VESSEL ACTIVITY AT THE RUBBING BEACHES

The higher rate of interactions by commercial fishermen was expected because they used the rubbing beach area more than other user groups. As Johnstone Strait forms part of an important and productive fisheries management area, it follows that there would more fishing boats around for longer periods than any other boat type. However, as commercial fishermen grow more interested in the "blackfish" and become more avid whale watchers, whale watching education must be extended to this group. In addition, very minor alterations in mooring and fishing patterns could significantly decrease the impact of this group on whales' use of the beaches.

Recreational whale watchers in power and sailboats, as well as commercial charters and tours are managed under the visitor information program and most abided by the ecological reserve guidelines. Under this program, visitors have been requested to stay clear of the reserve while there are whales in the vicinity. However, recreational users have entered the rubbing beach area to view whales there on occasions when the visitor information officer is not in the area and occasionally, even after contact by the information officer. Increased coverage may be needed.

E. OVERVIEW

Reaction types noted at the rubbing beaches were all examples of a change in normal behaviour by the whales. The whales made 18 short rubs when boats were not present and 57 when boats were present. Similarly, the whales passed by the beaches only 11 times when boats were not present, but did so 48 times when boats were present. The other reactions appeared to be clear responses to the presence of boats, as well.

The study shows that disturbances to the whales at the rubbing beaches and in the waters immediately adjacent to the reserve clearly have short-term effects on whale behaviour at the rubbing beaches. Some behaviours defined as reactions may have, in fact, been natural variation. However, overall impacts clearly exist. Although the study covers only two years and thus may not be sufficient to detect meaningful long-term impacts, whales responded in more than 70% of cases observed to avoid boat presence in proximity to the beaches.

Generally, use of Johnstone Strait and the rubbing beaches declined from 1987 to 1989. The numbers of whales sighted and the amount of time spent in the study area were considerably less. Declines were observed on a 'per whale' and 'per pod' for the number of visits and number of hours at the rubbing beaches. During the 1989 season, there was a decrease in diversity of family groups regularly seen in the Strait and at the beaches.

As the population of northern residents has increased between 1987 and 1989, the reduced number of whales in Johnstone Strait has resulted from changes in whale distribution rather than mortalities. The larger decline at the rubbing beaches could indicate a cumulative effect of human activities which negatively impacted on killer whales at the beaches. This increased activity within the reserve in 1989 related primarily to commercial fishing and whale watching activities. The data indicated that more whale watching is occurring among commercial fishermen, hikers, kayakers and recreational boaters. Also, new road construction is making the rubbing beaches more accessible to whale watchers. Outside the reserve, commercial fishing, commercial charter vessels, recreational boaters and researchers are affecting the whales use of the reserve.

However, it is possible that the decline in the Johnstone Strait area has resulted from other environmental changes, such as food supply. Further research is needed to determine if the whales use of the entire reserve area has decreased, as comparison with earlier data indicates, and to determine if this decrease is larger than the decrease observed in the Johnstone Strait itself.

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Appendix Table 1.
Number of Individuals Within Each Pod of the Northern Resident Community of Killer Whales During July-August, 1987, 1988 and 1989.

Pod	1987	1988	1989	Mean
A1	15	14	15	14.7
A4	8	8	8	8.0
A5	13	13	13	13.0
B1	8	8	8	8.0
C1	8	8	10	8.7
D1	12	12	12	12.0
G1	24	25	23	24.0
G12	11	11	12	11.3
H1	7	8	8	7.7
I1	7	7	8	7.3
I2	8	8	8	8.0
I11	14	14	14	14.0
I18	14	15	17	15.3
I31	7	9	9	8.3
R1	21	22	21	21.3
W1	3	3	3	3.0
Total	180	185	189	184.7

Appendix Table 2.
Number of Individuals Within Each Pod and Each Pod Subgroup of the Northern Resident Community of Killer Whales During July-August, 1987, 1988 and 1989.

Pod	Subgroup	1987	1988	1989
A1	A30	6	5	6
	A36	4	4	4
	A12	4	4	4
	A20	1	1	1
A4	A11	5	5	5
	A24	3	3	3
A5	A8	3	3	3
	A9	3	3	3
	A14	4	4	4
	A23	3	3	3
B1	B1	8	8	8
C1	C5	3	3	4
	C6	5	5	6
D1	D3	4	4	4
	D7	8	8	8
G1	G3	6	6	6
	G4	3	3	3
	G17	6	6	5
	G18	5	5	5
	G30	4	5	4
G12	G2	4	4	5
	G12	7	7	7
H1	H3	4	4	4
	H6	3	4	4
I1	I1	7	7	8
I2	I2	8	8	8
I11	I11	6	6	6
	I15	8	8	8
I18	I17	5	5	6
	I18	9	10	11
I31	I31	5	6	6
	I33	2	3	3
R1	R2	3	3	3
	R4	2	3	3
	R5	7	7	7
	R6	1	1	0
	R7	2	2	2
	R9	2	2	2
	R14, R15	2	2	2
W1	W1	3	3	3
Total		180	185	189

Appendix Table 3.
The Usage of Johnstone Strait and the Rubbing Beaches by Killer Whales
During July-August, 1987, 1988 and 1989,
as Indicated by the Number of Whale-days (1 whale seen on 1 day) Recorded.

	Johnstone Strait				Rubbing Beaches		
Pod	1987	1988	1989	% change	1987	1989	% change*
A1	407	418	372	-9%	312	259	-17%
A4	167	85	32	-81%	135	16	-88%
A5	339	209	60	-82%	264	23	-91%
B1	48	64	72	+50%	32	56	+75%
C1	144	102	196	+36%	96	168	+75%
D1	276	0	0	-100%	168	0	-100%
G1	57	0	0	-100%	39	0	-100%
G12	12	0	7	-42%	12	0	-100%
H1	91	48	32	-65%	77	24	-69%
I1	7	7	16	+129%	7	8	+14%
I2	16	32	16	0%	16	8	-50%
I11	64	32	34	-47%	50	28	-44%
I18	9	15	34	+278%	9	17	+89%
I31	40	54	39	-3%	30	24	-20%
R1	34	12	24	-29%	26	14	-46%
W1	15	6	3	-80%	15	0	-100%
Total	1726	1084	937	-46%	1288	645	-50%

* Change calculations include 1987 and 1989 data only.

Appendix Table 4.
Number of Days Killer Whales Were Sighted in Johnstone Strait and at the Rubbing Beaches During July-August,1987, 1988 and 1989.

		1987		1988	1989	
Pod	Subgroup	J.Strait	Beach	J.Strait	J.Strait	Beach
A1	A30	47	37	40	52	38
	A36	17	10	18	9	6
	A12	11	10	31	5	1
	A20	13	10	22	4	3
A4	A11	22	18	8	4	2
	A24	19	15	15	4	2
A5	A8	26	22	15	3	1
	A9	28	22	15	3	1
	A14	30	24	17	6	2
	A23	19	12	17	6	3
B1	B1	6	4	8	9	7
C1	C5	18	12	19	40	36
	C6	18	12	9	6	4
D1	D3	23	14	0	0	0
	D7	23	14	0	0	0
G1	G3	1	0	0	0	0
	G4	4	3	0	0	0
	G17	5	5	0	0	0
	G18	1	0	0	0	0
	G30	1	0	0	0	0
G12	G2	3	3	0	0	0
	G12	0	0	0	1	0
H1	H3	13	11	6	4	3
	H6	13	11	6	4	3
I1	I1	1	1	1	2	1
I2	I2	2	2	4	2	1
I11	I11	4	3	0	3	2
	I15	5	4	4	2	2
I18	I17	0	0	1	2	1
	I18	1	1	1	2	1
I31	I31	6	4	6	5	3
	I33	5	5	6	3	2
	R2	2	2	4	4	2
R1	R4	0	0	0	0	0
	R5	0	0	0	0	0
	R6	2	2	0	0	0
	R7	1	1	0	0	0
	R9	6	4	0	6	4
	R14,15	6	4	0	0	0
	R17	0	0	0	0	0
W1	W1	5	5	2	1	0
Total		407	307	275	188	131

Appendix Table 5.
Number of Whales Sighted in Johnstone Strait during July-August, 1987, 1988 and 1989, and at the Rubbing Beaches During July-August, 1987 and 1989.

	1987*	1988**	1989*	% change
N. resident population	180	185	189	+5%
# in Johnstone Strait	157	112	133	-15%
% in Johnstone Strait	87%	61%	70%	-17%
# at rubbing beaches	142	-	123	-13%
% of whales in Johnstone Strait at rubbing beaches	90.4%	-	92.5%	+2.1%

* 1987 and 1989 observations by Briggs.
** 1988 observations by other researchers in region.

Appendix Table 6.
Number of Whale-days and Whale Visits in Johnstone Strait During July-August, 1987, 1988 and 1989, and the Rubbing Beaches During July-August, 1987 and 1989.

Whale-days[1]	1987	1988	1989	% Change 1987-1989
- in Johnstone Strait	1726	1084	937	-46%
- at rubbing beaches	1288	-	645	-50%
- % at rubbing beaches	75%	-	69%	-6%
Mean # of whales/day[2]				
- Johnstone Strait	30	-	16	-47%
- rubbing beaches	22	-	11	-50%
Mean # of days/pod[3]			4.6	-54%
- in Johnstone Strait	9.9	6.7	3.2	-57%
- at rubbing beaches	7.5	-		
Total # of visits[4]				
- to Johnstone Strait	155	-	115	-26%
- to rubbing beaches	179	-	97	-46%
Mean # of visits/day[5]				
- to Johnstone Strait	2.67	-	1.92	-28%
- to rubbing beaches	3.08	-	1.62	-47%

[1] Based on Appendix Table 1 and Appendix Table 2.
[2] Based on Appendix Table 1 and 58 observation days during 1987 and 60 during 1989.
[3] Based on Appendix Table 4, using the number of subgroups.
[4,5] See Methods for definition of a visit.

Appendix Table 7.
Number of Whale-hours in Johnstone Strait and at the Rubbing Beaches During July-August, 1987 and 1989.

	1987	1989	% Changes 1989-1989
# of Whales			
- in Johnstone Strait	157	133	-15%
- at rubbing beaches	142	123	-13%
Whale-hours[1]			
- Johnstone Strait	16,294	8,714	-47%
- rubbing beaches	1,673	789	-53%
% of Whale-hours			
- at rubbing beaches	10%	9%	-10%
Mean # hours/whale[2]			
- in Johnstone Strait	103.8	65.5	-37%
- at rubbing beaches	11.8	6.4	-46%
Mean # hours/whale/day[3]			
- in Johnstone Strait	1.8	1.1	-39%
- at rubbing beaches	0.2	0.1	-50%

[1] Whale-hours are a summation of each visit by pod.
[2] Based on whale-hours divided by number of whales.
[3] Based on hours/whale for 58 observation days during 1987 and 60 observation days during 1989.

Appendix Table 8.
Vessel Activity in the 0-300 m Area at the Rubbing Beaches
During July-August, 1987 and 1989.

Vessel Type*		1987			1989		
		No Whales Present	Whales Present	Total	No Whales Present	Whales Present	Total
cbt	1-30m	176	29	205	218	13	231
	31-100m	371	51	422	744	28	772
	01-300m	33	31	64	449	42	491
cbf	1-30m	9	5	14	52	5	57
	31-100m	22	14	36	192	12	204
	101-300m	37	11	48	165	14	179
cbs	1-30m	17	4	21	50	5	55
	31-100m	13	3	16	77	4	81
	101-300m	0	1	1	12	2	14
gm	1-30m	0	0	0	7	0	7
	31-100m	11	3	14	46	5	51
	101-300m	11	1	12	22	3	25
kc	1-30m	66	6	72	33	3	36
	31-100m	0	0	0	1	5	6
	101-300m	0	0	0	4	1	5
rb	1-30m	22	6	28	26	4	30
	31-100m	61	8	69	75	16	91
	101-300m	4	7	11	57	3	60
ch	1-30m	0	1	1	0	0	0
	31-100m	0	2	2	0	1	1
	101-300m	0	3	3	0	2	2
re	1-30m	1	0	1	0	0	0
	31-100m	2	4	6	3	2	5
	101-300m	0	0	0	4	0	4
ph	1-30m	0	1	1	1	0	1
Total		856	191	1,047	2,238	170	2,408

* Vessel type:
cbt - commercial fishing boat travelling
cbf - commercial fishing boat fishing
cbs - commercial fishing boat skiff
ch - commercial whale watch
gm - general marine traffic
rb - recreational
re - research
kc - kayak
ph - photographers

Appendix Table 9.
Levels of Human Activities at the Rubbing Beaches During 1987 and 1989.

	1987		1989		% Change 1987-1989	
			# vessel (# when visits whales present)			
Commercial Fishing	827	(149)	2084	(125)	+152%	(-16%)
Recreational Boats	108	(21)	181	(23)	+68%	(+10%)
Kayaks	72	(6)	47	(9)	-35%	(+50%)
General Marine	26	(4)	83	(8)	+219%	(+100%)
Research	7	(4)	9	(2)	+29%	(-50%)
Comm. Whale	6	(6)	3	(3)	-50%	(-50%)
Watch	1	(1)	1	(0)	0%	(-100%)
Photographers						
Total	1047	(191)	2408	(170)	+130%	(-11%)
			# vessel landings (# when whales present)			
Comm. Fishing	1	(1)	19	(2)	+1900%	(+100%)
Skiffs	0	(0)	8	(2)	+800%	(+100%)
Kayaks	1	(1)	0	(0)	-100%	(-100%)
Recreational						
Total	2	(2)	27	(3)	+1250%	(+50%)
			# gunshots (# when whales present)			
Comm. Fishing	many	(2)	+500	(18)	-	(-)
Boats	0	(0)	0	(0)	-	(-)
Other Boats						
			# day use on shore (# when whales present)			
Comm. Fishermen						
Hike	0	(-)	10	(0)	-	(-)
Tie Mooring lines	0	(-)	3	(0)	-	(-)
Whale Watch	0	(0)	2	(2)	-	(-)
Check Targets	0	(-)	2	(0)	-	(-)
Make a Fire	0	(-)	1	(0)	-	(-)
Saw Research Camp	0	(-)	1	(0)	-	(-)
Sub Total	0	(0)	9	(2)	-	(-)
Recreational Users						
Look for Camp Spot	0	(-)	4	(0)	-	(-)
Whale Watch	2	(2)	1	(1)	-	(-)
Short Rest	0	(-)	2	(0)	-	(-)
Picnic	0	(-)	1	(0)	-	(-)
Hikers	0	(-)	1	(1)	-	(-)
Sub Total	2	(2)	8	(2)	-	(-)
Total	2	(2)	27	(4)	-	(-)

Appendix Table 10.
Interactions Between Killer Whales and Human Activities in Waters Immediately Adjacent to the Reserve and the Rubbing Beaches During 1987 and 1989. *

		1987		1989	% Change 1987-1989	
1. Johnstone Strait						
		# whale approaches to reserve(# with interactions)				
All Vessels	-	(-)	45	(41)	-	(-)
2. Rubbing Beaches						
		# vessel interactions(# with reactions)				
Commercial Fishing	123	(97)	144	(98)	+17%	(+1%)
Recreational Boats	21	(17)	28	(27)	+33%	(+59%(
Kayaks	2	(2)	12	(11)	+600%	(+550%)
General Marine	5	(3)	8	(7)	+60%	(+133%)
Comm. Whale	4	(3)	3	(1)	-25%	(-67%)
Watch	3	(2)	1	(1)	-67%	(-50%)
Researcher	2	(1)	0	(0)	-100%	(-100%)
Photographers						
Total	160	(125)	196	(145)	+23%	(+16%)
		# vessel landing interactions (# with reactions)				
Comm. Fishing	1	(1)	2	(2)	+100%	(+100%)
Skiffs	0	(-)	2	(2)	-	(-)
Kayaks	1	(1)	0	(-)	-100%	(-100%)
Recreational						
Total	2	(2)	4	(4)	+100%	(+100%)
		# gunshot interactions (# with reactions)				
Comm. Fishing	1	(1)	2	(1)	+100%	(0)
Boats	0	(0)	0	(0)	-	(-)
Other Boats						
		# day use interactions on shore (# with reactions)				
Comm. Fishermen	0	(0)	2	(2)	-	(-)
Recreational Users	2	(2)	1	(1)	-100%	(-100%)
Total	2	(2)	3	(3)	+50%	(+50%)

* See Methods for types of reactions.

Appendix Table 11.
Frequency of Responses by Killer Whales to Interactions with Commercial Fishing Vessels (CF), Whale Watching Vessels* (WW) and General Marine Traffic (GM) at the Rubbing Beaches During 1987 and 1989.

	CF	WW	GM	Total	Mean
Interactions from vessel visits					
No Reaction	72	11	3	86	28.7
Reaction	195	65	10	270	90.0
Leave the Area	84	25	0	109	36.3
Short Rub	42	11	4	57	19.0
Passed By	32	12	4	48	16.0
Leave and Return	26	13	1	40	13.3
Wait to Rub	9	4	0	13	4.3
Change Direction	2	0	1	3	1.0
Total	267	76	13	356	118.3
Interactions from Vessel Landings					
No Reaction	0	0	-	0	0.0
Reaction (Leave Area)	3	2	-	5	2.5
Interactions from Gunfire					
From Comm. Fishing	1	-	-	1	1.0
Boats No Reaction	2	-	-	2	2.0
Reaction (Leave Area)	3	-	-	3	3.0
Total					
Interactions From					
Day Use	0	0	-	0	0.0
No Reaction	3	3	-	6	3.0
Reaction	3	2	-	5	2.5
Leave the Area	0	1	-	1	0.5
Short Rub					

* Whale watching includes commercial and recreational whale watching, research and photography boats.

Appendix Table 12.
Killer Whale Responses to Commercial and Recreational Vessel Approaches at the Rubbing Beaches During July-August 1987 and 1989. *

	Vessel Type									
Interactions from vessel visits	cbt	cbf	cbs	gm	kc	rb	ch	re	ph	Total
No Reaction	48	19	5	3	1	5	3	1	1	86
Reaction	128	52	15	10	13	44	4	3	1	270
Leave the Area	67	9	8	0	4	15	3	3	0	109
Short Rub	12	27	3	4	5	6	0	0	0	57
Passed By	17	13	2	4	3	9	0	0	0	48
Leave and Return	22	2	2	1	0	12	1	0	0	40
Wait to Rub	8	1	0	0	1	2	0	0	1	13
Change Direction	2	0	0	1	0	0	0	0	0	3
Total	176	71	20	13	14	49	6	4	2	356
Interactions from vessel landings										
No Reaction			0		0	0				0
Reaction (Leave Area)			3		1	1				5

* See Methods for definition of each reaction type and Appendix Table 8 for vessel type codes.

Appendix Table 13.
Frequency of Killer Whale Responses to Interactions with Various Vessel Types at the Rubbing Beaches by Distance from Shore During July-August 1987 and 1989.*

	Vessel Distance from Shore			
	1-30m	31-100m	101-300m	Total
No Reaction	7	30	49	86
Reaction	72	122	76	270
Leave the area	34	52	23	109
Short Rub	12	21	24	57
Passed By	10	26	12	48
Leave and Return	9	19	12	40
Wait to Rub	7	4	2	13
Change Direction	0	0	3	3
Total	79	152	125	356

* See Methods for definition of each reaction type.